Summary of Changes

Geospatial Technology Competency Model (GTCM)

The Geospatial Technology Competency Model was updated in October 2023. Competencies throughout the model were updated based on feedback from industry subject matter experts and public comments received on the model. The updates are as follows:

**Global Changes**

*For clarity, global changes are not listed individually in the following summary.*

* Added end punctuation to all key behavior descriptions and critical work functions, but not technical content areas.
* Edited capitalization to follow current CMC style:
  + Competency block titles in title case
  + Key behavior titles in sentence case with no ending punctuation
  + Key behavior descriptions, critical work functions, and technical content areas in sentence case

**Tier 1: Personal Effectiveness Competencies**

* **1.1 Interpersonal Skills**
  + 1.1.1 Respecting diversity
    - *Edited key behavior description:*
      * ~~1.1.1.4 Be flexible and open-minded when dealing with a wide range of people.~~ Use appropriate strategies and solutions for dealing with conflicts and differences to maintain a smooth workflow.
    - *Renumbered key behavior description.*
      * ~~1.1.1.6~~ 1.1.1.5 Listen to and consider others’ viewpoints.
* **1.3 Professionalism**
  + 1.3.1 Demonstrating self-control
    - *Edited key behavior description:*
      * 1.3.1.3 ~~Refrain from~~ Recognize the personal and professional effects of substance abuse.
  + 1.3.2 Maintaining a positive attitude
    - *Edited key behavior description:*
      * 1.3.2.2 ~~Strengthen your profession by mentoring junior colleagues~~ Champion and ~~championing continuing~~ support continual professional development and mentoring.
* **1.4 Initiative**
  + Competency description
    - *Edited competency description:*
      * Demonstrating ~~gumption at work~~ a commitment to effective job performance by taking action on one’s own and following through to get the job done.
  + Key behavior titles
    - Deleted key behavior title:
      * ~~1.4.3 Setting challenging goals~~
  + 1.4.1 Taking initiative
    - *Edited key behavior description:*
      * 1.4.1.1 Take the initiative in seeking out new responsibilities and establish challenging work ~~challenges~~ goals while not compromising existing obligations.
  + 1.4.3 Setting challenging goals
    - *Deleted key behavior description:*
      * ~~1.4.3.1 Establish and maintain personally challenging but realistic work goals.~~
  + 1.4.3 Achievement motivations
    - *Renumbered key behavior title and key behavior:*
      * ~~1.4.4~~ 1.4.3 Achievement motivations
      * ~~1.4.4.1~~ 1.4.3.1 Strive to exceed standards and expectations.
* **1.5 Dependability and Reliability**
  + 1.5.1 Fulfilling obligations
    - *Added key behavior descriptions:*
      * 1.5.1.1 Establish and follow expectations for professional behavior in the workplace.
      * 1.5.1.3 Work and problem-solve in an organized and systematic manner.
    - *Deleted key behavior description:*
      * ~~1.5.1.1 Behave consistently, predictably, and reliably.~~
  + 1.5.2 Following directions
    - *Edited key behavior description:*
      * 1.5.2.2 Recognize, understand, and comply with organizational rules, policies, and procedures.
* **1.6 Lifelong Learning**
  + 1.6.1 Demonstrate an interest in learning
    - *Edited key behavior description:*
      * 1.6.1.2 Seek feedback, consider its value, and modify workplace behavior as needed for professional improvement.
  + 1.6.3 Participate in learning activities
    - *Added key behavior description:*
      * 1.6.3.4 Maintain and increase oral and written communication skills.
    - *Edited and renumbered key behavior description:*
      * ~~1.6.3.4~~ 1.6.3.3 Seek, prioritize, and maintain membership in professional associations, certifications, and continuing education credits.
    - *Deleted key behavior description:*
      * ~~1.6.3.2 Seek and maintain membership in professional associations.~~
    - *Renumbered key behavior description:*
      * ~~1.6.3.3~~ 1.6.3.2 Read technical publications to stay abreast of new developments in the industry.

**Tier 2: Academic Competencies**

* **2.1 Reading**
  + 2.1.1 Comprehension
    - *Edited key behavior description:*
      * 2.1.1.1 Locate~~, understand,~~ and interpret ~~written~~ technical and non-technical information ~~in documents such as charts, graphs, manuals, maps, memos, records, reports, schedules, surveys, tables, and titles~~.
  + 2.1.2 Information analysis
    - *Edited key behavior description:*
      * 2.1.2.2 ~~Discriminate reliable from unreliable sources~~ Investigate and critically evaluate the accuracy and reliability of information and data sources.
* **2.2 Writing**
  + 2.2.2 Mechanics
    - *Added key behavior description:*
      * 2.2.2.5 Abide by copyright and intellectual property laws and regulations.
    - *Edited key behavior descriptions:*
      * 2.2.2.3 ~~Write in a manner appropriate for business;~~ Use language appropriate for the target audience; avoid unnecessary jargon; use appropriate tone and word choice (i.e., writing is professional and courteous).
      * 2.2.2.4 Avoid plagiarism and protect intellectual property rights by ~~paraphrasing,~~ citing~~,~~ and correctly referencing sources ~~properly~~.
* **2.3 Mathematics**
  + Key behavior titles
    - *Deleted key behavior title:*
      * ~~Know and apply mathematical principles:~~
  + Key behavior descriptions
    - *Edited key behavior descriptions:*
      * 2.3.1 Number Systems and Relationships ~~–~~: whole numbers, decimals, fractions, ~~and~~ percentages, and significant digits.
      * 2.3.2 Number Operations and Computation ~~–~~: addition, subtraction, multiplication, and division.
      * 2.3.3 Measurement and Estimation ~~–~~: measurement of time, temperature, distances, length, width, height, perimeter, area, volume, weight, velocity, and speed; unit conversion; numerical analysis to obtain approximate solutions when necessary.
      * 2.3.4 Mathematical Notation ~~–~~: the language of mathematics to express mathematical ideas.
      * 2.3.5 Mathematical Reasoning and Problem Solving ~~–~~: inductive and deductive reasoning, conjectures, arguments, strategies, and interpretation of results.
      * 2.3.6 Statistics and Probability ~~–~~: standard deviation, variance, tests of significance, sampling, probability, and confidence intervals.
      * 2.3.7 Algebra ~~–~~: equations, patterns, functions, 3D vectors, and matrices.
      * 2.3.8 Geometry ~~–~~: size, shape, and position of figures; using geometric principles to solve problems.
      * 2.3.9 Trigonometry ~~–~~: relationships among the sides and angles of triangles ~~on planes and spheres~~ and with the relevant functions of any angles.
* **2.4 Geography**
  + Key behavior titles
    - *Deleted key behavior title:*
      * ~~Know and apply geographic skills, including:~~
  + 2.4.1 Subject-specific geographic knowledge
    - *Edited key behavior descriptions:*
      * 2.4.1.1 Human-Environment Interaction: Know and apply geographic information about relationships between nature and society (e.g., pollution from industrial development, and the economic effects of drought).
      * 2.4.1.3 Physical Geography: Know and apply geographic information about the processes that shape physical landscapes~~;~~ (e.g., weather, climate and atmospheric processes~~;~~, ecosystems and ecological processes~~;~~, and natural hazards).
      * 2.4.1.4 Cultural Geography: Know and apply geographic information about culture and cultural processes~~, including~~ (e.g., religion, language, ethnicity, diffusion, meaning of landscapes, and cultural significance of place).
  + 2.4.2 Geographic skills
    - *Edited key behavior descriptions:*
      * 2.4.2.1 Geographic Information Systems (GIS): Use GIS geospatial tools to acquire, manage, display, and analyze spatial data in digital form.
      * 2.4.2.2 Cartography: Producing, creating, and designing ~~paper or digital~~ maps and other types of visualizations.
  + 2.4.3 Geographic perspectives
    - *Edited key behavior descriptions:*
      * 2.4.3.1 Spatial Thinking: Identify, explain, and find meaning in spatial patterns and relationships, such as site conditions~~,~~; how places are similar and different~~,~~; the influence of a land feature on its neighbors~~,~~; the nature of transitions between places~~,~~; how places are linked at local, regional, and~~/or~~ global scales.
      * 2.4.3.3 Interdisciplinary Perspective: Draw on and synthesize the information, concepts, and methods of the natural and social sciences for geographic research and applications.
* **2.5 Science and Engineering**
  + Key behavior titles
    - *Added key behavior titles:*
      * 2.5.1 Scientific methods
      * 2.5.3 Engineering methods
    - *Deleted key behavior titles:*
      * ~~Scientific knowledge and methods:~~
      * ~~Engineering knowledge and methods:~~
  + 2.5.1 Scientific methods
    - *Edited and renumbered key behavior descriptions:*
      * ~~2.5.1~~ 2.5.1.1 ~~Scientific Method –,~~ Apply the scientific method to the pursuit of knowledge, i.e., the systematic pursuit of knowledge involving the recognition and formulation of a problem, the collection of data through observation and experiment, and the formulation and testing of a hypothesis.
      * ~~2.5.1.1~~ 2.5.1.2 ~~Understand~~ Acknowledge the physical and social science that is appropriate to a chosen geospatial application domain.
  + 2.5.2 Subject-specific scientific knowledge
    - Edited key behavior descriptions:
      * 2.5.2.1 ~~Physical Sciences, such as Agricultural Science – production of goods through the growing of plants, animals, and other life forms; Biology – the phenomena of life and living organisms; Environmental Science/Ecology – the relationships between organisms and their environments; Forestry – the cultivation, maintenance, and management of forests; Geology – the origin, history, and structure of the earth; Hydrology – properties, distribution, and effects of water on the Earth's surface; Meteorology and Climatology – phenomena of the atmosphere, especially weather and weather conditions; Oceanography – scientific study of oceans, the life that inhabits them, and their physical characteristics; Physics – matter and energy and their interactions~~ Apply knowledge of physical sciences in the workplace, as appropriate, including:
        + Agricultural Science: production of goods through the growing of plants, animals, and other life forms;
        + Biology: the phenomena of life and living organisms;
        + Environmental Science(Ecology): the relationships between organisms and their environments;
        + Forestry: the cultivation, maintenance, and management of forests;
        + Geology: the origin, history, and structure of the earth;
        + Hydrology: the properties, distribution, and effects of water on the Earth's surface;
        + Meteorology and Climatology: phenomena of the atmosphere, especially weather and weather conditions;
        + Oceanography: the scientific study of oceans, the life that inhabits them, and their physical characteristics; and
        + Physics: matter and energy and their interactions.
      * 2.5.2.2 ~~Social sciences, such as Anthropology – the origins and social relationships of human beings; Demography – the characteristics of human populations; Economics – the production, distribution and consumption of goods and services and their management; History – the interpretation of past events involving human beings; Political Science – the government of states and other political units; and Sociology – the study and classification of human societies~~ Apply knowledge of social sciences in the workplace, as appropriate, including:
        + Anthropology: the origins and social relationships of human beings;
        + Demography: the characteristics of human populations;
        + Economics: the production, distribution and consumption of goods and services and their management;
        + History: the interpretation of past events involving human beings;
        + Political Science: the government of states and other political units; and
        + Sociology: the study and classification of human societies.
  + 2.5.3 Engineering methods
    - *Edited key behavior descriptions:*
      * 2.5.3.1 ~~Design –~~Apply design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.
      * 2.5.3.1 Employ engineering technologies, including computer-aided engineering and drafting, site surveying, leveling, and ground-based laser scanning.
    - *Deleted key behavior descriptions:*
      * ~~2.5.3.3 Understand the engineering disciplines that are appropriate to a chosen geospatial application domain.~~
  + 2.5.4 Subject-specific engineering knowledge
    - *Edited key behavior descriptions:*
      * 2.5.4.1 ~~Familiarity with applications~~ Integrate knowledge of ~~science and~~ the relevant engineering ~~principles~~ disciplines into work in a chosen geospatial application domain.
* **2.6 Communication – Listening and Speaking**
  + 2.6.1 Listening
    - *Edited key behavior description:*
      * 2.6.1.1 Receive, interpret, ~~understand,~~ and respond to verbal messages and other cues.
    - *Deleted key behavior description:*
      * ~~2.6.1.3 Pick out important information in verbal messages.~~
  + 2.6.2 Speaking and presenting
    - *Edited key behavior descriptions:*
      * 2.6.2.1 Speak clearly and confidently ~~using common English conventions including proper grammar, tone, and pace~~.
      * 2.6.2.2 ~~Express information to individuals or groups taking into account the audience and the nature of the information (e.g., explain technical concepts to non-technical audiences).~~ Communicate effectively to any audience.
* **2.7 Critical and Analytical Thinking**
  + 2.7.1 Reasoning
    - *Edited key behavior descriptions:*
      * 2.7.1.5 ~~Organize problems into manageable parts.~~ Break complex information and tasks down into simplified, generalized components that can be applied to other problems.
* **2.8 Basic Computer Skills**
  + Key behavior titles
    - *Added key behavior title:*
      * 2.8.9 Cybersecurity and privacy
  + 2.8.1 Navigation and file management
    - *Edited key behavior description:*
      * 2.8.1.1 ~~Use scroll bars, a mouse, and dialog boxes to work within the computer's operating system.~~ Work simultaneously with a variety of computer tools.
    - *Deleted key behavior description:*
      * ~~2.8.1.2 Access and switch between applications and files of interest.~~
  + 2.8.2 Internet and e-mail
    - *Edited key behavior descriptions:*
      * 2.8.2.1 ~~Navigate the Internet to find information.~~ Conduct research on a topic, finding prior relevant studies and synthesizing information.
      * 2.8.2.4 ~~Send and retrieve electronic mail (e-mail).~~ Communicate using email, social media, and other means in a professional setting.
      * ~~2.8.2.7~~ 2.8.2.6 ~~Navigate the Internet to find~~ Locate and attend online training~~, web conferences, webinars, self-paced training, and other applicable interactive sites~~ opportunities.
    - *Renumbered key behavior descriptions:*
      * ~~2.8.2.6~~ 2.8.2.5 Manage personal schedule and contact information.
      * ~~2.8.2.8~~ 2.8.8.7 Employ collaborative/groupware applications to facilitate group work.
  + 2.8.3 Writing and publishing applications
    - *Deleted key behavior descriptions:*
      * ~~2.8.3.2 Format, edit, and print text.~~
      * ~~2.8.3.3 Save and retrieve word processing documents.~~
  + 2.8.6 Database
    - *Edited key behavior descriptions:*
      * 2.8.6.2 Create and edit ~~simple~~ basic databases.
      * 2.8.6.5 Create reports to communicate ~~the~~ information.
  + 2.8.7 Computer programming and algorithms
    - *Edited key behavior description:*
      * 2.8.7.1 ~~Basic~~ Interpret computer code with a basic level of understanding ~~or~~ and appreciation ~~of~~ for programming ~~language~~ principles.
  + 2.8.9 Cybersecurity and privacy
    - *Added key behavior descriptions:*
      * 2.8.9.1 Comply with employers' remote work requirements.
      * 2.8.9.2 Adhere to employers' rules and protocols on social media activities.
      * 2.8.9.3 Understand the risks and opportunities within a robust and expanding data and information domain (e.g., cybersecurity awareness, big data management, etc.).

**Tier 3: Workplace Competencies**

* **3.1 Teamwork**
  + 3.1.1 Identifying team membership and role
    - *Edited key behavior description:*
      * 3.1.1.1 Accept membership in the team and identify with its goals and objectives, recognizing the responsibilities of being a member.
* **3.2 Creative Thinking**
  + 3.2.1 Employing unique analyses
    - *Edited key behavior description:*
      * 3.2.1.2 Develop innovative methods of obtaining alternate or using available resources when ~~insufficient~~ specified resources are ~~available~~ unavailable or restricted.
* **3.3 Planning and Organizing**
  + 3.3.1 Planning and Organizing
    - *Edited key behavior description:*
      * 3.3.1.5 Keep track of details to ensure work is performed accurately and completely so that results can be reproduced or replicated.
  + 3.3.2 Adaptability and flexibility
    - *Edited key behavior descriptions:*
      * 3.3.3.4 Ensure that others receive needed ~~materials~~ resources or assets in time.
      * 3.3.3.5 ~~Stay on schedule.~~ Set realistic deadlines and adhere to them.
      * 3.3.3.7 ~~Working remotely.~~ Work remotely as required in an at-home office, some designated alternate space, or during travel assignments.
    - *Deleted key behavior descriptions:*
      * ~~3.3.3.8 Understand or appreciate the impact of working remotely.~~
      * ~~3.3.3.9 Capability to work remotely as required.~~
* **3.4 Problem Solving and Decisions Making**
  + 3.4.2 Generate alternatives
    - Edited key behavior descriptions:
      * 3.4.2.2 Think creatively to develop and share new ideas ~~for and answer~~ to resolve work-related problems.
      * 3.4.2.4 Build or apply models to conceptualize and develop theoretical and practical frameworks.
  + 3.4.3 Choose and implement a solution
    - Edited key behavior description:
      * 3.4.3.2 Commit to providing a solution in a timely manner.
* 3.5 Working with Tools and Technology
  + 3.5.2 Using Tools
    - *Edited key behavior description:*
      * 3.5.2.2 Use information technology and computer applications as ~~it supports~~ they support the gathering, storage, manipulation, and transfer of data and information.
  + 3.5.3 Keeping current on tools and technology
    - *Edited key behavior description:*
      * 3.5.3.3 Seek ~~out~~ opportunities to improve knowledge of tools and technologies that may ~~asses~~ assist in streamlining work and improving productivity.
  + 3.5.4 Troubleshooting and maintenance
    - *Edited key behavior descriptions:*
      * 3.5.4.1 Help people adapt to the changes brought on by new technologies and ~~helping them to~~ see the value and benefits of new technology.
      * 3.5.4.2 Troubleshoot ~~and~~, maintain, update, and secure tools and technologies.
* 3.6 Checking, Examining, and Recording
  + 3.6.1 Obtaining information
    - *Edited key behavior descriptions:*
      * 3.6.1.1 Compile, code, categorize, calculate, tabulate, audit, or verify ~~information or~~ data.
      * 3.6.1.2 ~~Perform with rigorous~~ Rigorously assess data quality for exactness and a high degree of accuracy.
* 3.7 Business Fundamentals
  + Key behavior titles
    - *Deleted key behavior title:*
      * 3.7.1 Economic/Business/Financial Principles
    - *Renumbered key behavior titles:*
      * Renumbered key behavior titles 3.7.2-3.7.6 as 3.7.1-3.7.5 and renumbered key behavior descriptions accordingly.
  + 3.7.1 Economic/Business/Financial Principles
    - *Deleted key behavior description:*
      * ~~3.7.1.1 Basic understanding of markets, economic terminology, and business principles.~~
  + 3.7.2 Business ethics
    - *Edited key behavior descriptions:*
      * 3.7.2.1~~–~~ Act in the best interests of the company, your co-workers, your community, other stakeholders, and the environment.
      * 3.7.2.2 Legal~~/~~ and financial
        + Comply with the letter and spirit of applicable laws.
        + Use company property legitimately, minimizing loss and waste; report loss, waste, or theft of company property to appropriate personnel.
        + Maintain privacy and confidentiality of company and organization information, as well as that of customers and co-workers.
        + Comply with intellectual property laws.
        + Protect trade secrets.
      * 3.7.2.3 Environmental~~/Health/~~, health, and safety
        + Hold paramount the safety, health, and welfare of the public, stakeholders, clients, and internal employees.
        + Maintain a healthful and safe environment and report any violations~~/~~ or discrepancies.
        + Ensure equipment and systems are designed to be environmentally friendly and strive to continually minimize the resulting carbon footprint.
      * 3.7.2.4 Social
        + Emphasize quality, customer satisfaction, and fair pricing.
        + ~~Deal~~ Work with stakeholders, customers, clients, and others in good faith~~; no bribes, kickbacks, or excessive hospitality~~, with transparency, equity, and integrity.
        + Recognize and resist temptations to compete unfairly.
  + 3.7.3 Marketing
    - *Edited key behavior description:*
      * 3.7.3.4 Understand and integrate internal ~~and~~ or external customer demands and needs into the product.
  + 3.7.5 Geospatial business fundamentals
    - *Edited key behavior description:*
      * 3.7.5.1 Demonstrate awareness of the various professions, agencies, and firms that ~~comprise~~ compose the geospatial technology industry.

**Tier 4: Industry-Wide Technical Competencies**

* **4.1 Crosscutting Geospatial Abilities and Knowledge**
  + Critical work function titles
    - Edited critical work function title:
      * 4.1.6 Geographic information systems
  + Technical content areas title
    - Edited technical content areas title:
      * Technical Content Areas: Headings correspond to select knowledge areas identified in the first edition of the ~~GIS&T~~ Geographic Information Science and Technology (GIS&T) Body of Knowledge (UCGIS 2006 Technical Content Areas as modified during the 2018 GTCM review).
  + 4.1.1 Earth geometry and geodesy
    - *Edited critical work functions:*
      * 4.1.1.1 ~~Discuss~~ Represent locations as coordinates accurately by considering the ~~roles~~ role of ~~several~~ various geometric approximations of the earth’s ~~shape, such as geoids~~ (e.g., spheroids, ellipsoids, and ~~spheres~~ geoids).
      * 4.1.1.2 ~~Describe characteristics and appropriate uses of~~ Properly apply common geospatial coordinate systems, such as geographic (latitude and longitude), Universal Transverse Mercator (UTM), and the State Plane ~~Coordinates~~ Coordinate System (SPCS).
      * 4.1.1.3 ~~Explain the relationship of~~ Relate horizontal datums~~, such as North America Datum of 1983 (NAD 83) or the World Geodetic System of 1984 (WGS 84),~~ and vertical datums to coordinate system grids and geometric approximations of the earth’s ~~shape~~ ~~surface~~.
      * 4.1.1.4 ~~Describe characteristics and appropriate uses of~~ Use common map projections~~, such as~~ (e.g., Transverse Mercator, Lambert Conformal Conic, Albers Conic Equal Area~~, Azimuthal Equidistant, and Polar Stereographic~~) appropriately with consideration to their respective characteristics.
  + 4.1.2 Data quality
    - *Edited critical work functions:*
      * 4.1.2.1 ~~Discuss~~ Evaluate the ~~elements~~ quality of geospatial data ~~quality~~, including geometric accuracy, thematic accuracy, resolution, precision, and fitness for use.
      * 4.1.2.2 Implement methods for quality control and quality assurance in the context of a given geospatial project~~, explain the difference between quality control and quality assurance~~.
      * 4.1.2.3 ~~Identify~~ Anticipate and control for data quality and integration problems likely to be associated with geospatial and attribute data acquired with legacy systems, processes, and crowd sourcing.
      * 4.1.2.4 Calculate and interpret statistical methods and measures of the accuracy of a digital data set~~, such as~~ (e.g., root mean square error (RMSE), ~~linear regression and standard deviation~~ Confidence Interval, Least Significant Difference, etc.).
  + 4.1.3 Positioning systems
    - *Edited critical work functions:*
      * 4.1.3.1 ~~Describe~~ Identify the ~~basic~~ components ~~and operations~~ of the Global Navigation Satellite System (GNSS)~~, such as the Global Positioning System (GPS) and similar systems)~~ suited for use on a given geospatial project.
      * 4.1.3.2 ~~Explain the role of~~ Use GNSS ~~in~~ location-based services appropriately.
      * 4.1.3.3 Collect location data using satellite navigation systems and integrate ~~GNSS positions and associated attribute data~~ with other geospatial data sets.
      * 4.1.3.3 ~~Describe characteristics and appropriate uses of~~ Utilize electrical and mechanical inertial measurement units (IMU) appropriately.
  + 4.1.4 Remote sensing and photogrammetry
    - *Edited critical work functions:*
      * 4.1.2.1 ~~Explain the value~~ Select appropriate ranges and bands of the electromagnetic spectrum that are useful for a remote sensing operation.
      * 4.1.2.3 ~~Describe characteristics, difference~~ ~~and appropriate uses of~~ Select and use active and passive ~~sensors~~ sensor information (e.g., optical, microwave, multispectral, hyperspectral, etc.) appropriately based the characteristics of each type.
      * ~~4.1.2.5~~ 4.1.2.4 ~~Explain the use of sampling~~ Use ground truth data ~~for~~ in quality assurance ~~in~~ procedures for remote sensing data.
      * ~~4.1.4.6~~ 4.1.4.5 ~~Explain~~ ~~Apply basic~~ photogrammetric principles, including the measuring techniques of triangulation, to extract coordinates and dimensions from photographs or images.
    - *Deleted critical work function:*
      * ~~4.1.4.4 Compare the capabilities and limitations of various sensor types in the context of project requirements.~~
    - *Renumbered critical work function:*
      * ~~4.1.4.7~~ 4.1.4.6 Compare the capabilities and limitations of various sensor platforms such as satellites, terrestrial, aircraft and unmanned aerial vehicles (UAVs).
  + 4.1.6 Geographic information systems
    - Edited critical work functions:
      * 4.1.6.1 ~~Demonstrate understanding of the conceptual foundations on which geographic information systems (GIS) are based, including the problem of representing change over time and the imprecision and uncertainty that characterizes all geographic information.~~ Use geographic information systems (GIS) appropriately with respect to their capabilities and limitations.
      * 4.1.6.2 ~~Use geospatial hardware and software tools to digitize and georeference a paper map or plat.~~ Georeference and digitize legacy spatial products, such as paper maps and photographs.
      * 4.1.6.5 ~~Compare advantages and disadvantages of~~ Select appropriate standard spatial data models, ~~including the nature of~~ such as vector~~,~~ and raster, and ~~object-oriented models, in the context of spatial data used in the workplace~~ file formats based on them, to suit project requirements.
      * 4.1.6.6 ~~Describe examples of geospatial data analysis in which~~ Employ analytical tools to evaluate and employ spatial relationships ~~such as~~, including distance, direction, and ~~topologic relationships~~ topology (e.g., adjacency, connectivity, and ~~overlap) are particularly relevant~~ contiguity).
      * 4.1.6.7 Use ~~geospatial~~ software tools to perform ~~basic GIS~~ geospatial analysis functions, including spatial measurement, data query and retrieval, vector overlay, raster map algebra ~~and to use large datasets (e.g., big data)~~, and similar activities.
      * 4.1.6.8 ~~Demonstrate a working knowledge of GIS~~ Select appropriate geospatial hardware and software based on their capabilities and project requirements.
  + 4.1.7 Programming, application development, and geospatial information technology
    - *Added critical work function:*
      * 4.1.7.9 Identify potential interoperability issues between software applications.
    - *Edited critical work functions:*
      * 4.1.7.1 ~~Demonstrate understanding of common geospatial algorithms, such as geocoding or drive time analysis, by writing or interpreting pseudo code.~~ Implement the principles and algorithms upon which geoprocessing tools are built.
      * 4.1.7.3 ~~Identify~~ Evaluate the appropriateness of using one or more of the alternatives for customization and automation, such as Application Programming Interfaces (APIs), Software Development Kits (SDKs), or scripting languages.
      * 4.1.7.4 ~~Identify the information technology components of a GIS, such as databases, software programs, application servers, data servers, SAN Devices, workstations, switches, routers, and firewalls.~~ Integrate GIS into Information Technology (IT) infrastructures, including server hardware and software, databases, networking applications, and virtual environments.
      * 4.1.7.5 Compare the benefits and shortcomings of desktop, server, enterprise, and hosted (cloud) architectures for software ~~applications~~ ~~services and data storage~~.
      * 4.1.7.6 Discuss trends in geospatial technology and applications so that the organization can confidently plan for the future.
      * 4.1.7.7 ~~Compare the capabilities, limitations, and the ability to integrate of~~ Integrate data into different ~~types of~~ geospatial software, such as GIS, Computer Aided Design (CAD), Building Information Modeling (BIM~~, GIS, and~~), image processing, and similar applications.
      * 4.1.7.8 ~~Recognize opportunities to leverage positioning technology to~~ Create mobile ~~end-user~~ applications that leverage spatial data and location services.
  + 4.1.10 Geospatial data
    - *Edited technical content area:*
      * 4.1.10.12 Metadata, standards (e.g., International Organization for Standardization (ISO), Federal Geographic Data Committee (FGDC), Open Geospatial Consortium (OGC)) and spatial data infrastructure
* **5.1 Positioning and Data Acquisition**
  + Competency description
    - *Edited competency description:*
      * ~~Knowledge of~~ Understanding and working with the unique geometric and thematic properties of geospatial data, the factors that affect data quality, and data production technologies~~. Includes~~, including: data collection, data capture methods, and technologies used to collect georeferenced observations and measurements.
  + Critical work functions
    - *Added critical work function:*
      * 5.1.24 Combine internal and external spatial data (e.g., BIM, CAD, etc.).
    - *Edited critical work functions:*
      * 5.1.1 Use geospatial software to transform ellipsoid, datum, and/or a map projection to georegister one set of geospatial data to another.
      * 5.1.3 ~~Discuss examples of~~ Interpret and use land records based on both systematic and unsystematic land partitioning systems ~~in the U.S. and their implications for land records~~.
      * 5.1.5 Explain the distinction between a property boundary and its representations, such as deed lines, lines on imagery, ~~and~~ boundary depictions in cadastral (land records) databases.
      * 5.1.6 ~~Plot~~ Digitize parcel data from a legal boundary description ~~from~~ ~~in~~ a deed or plat.
      * 5.1.7 Design a ~~system~~ process for acquiring, processing, and integrating geospatial data from diverse sources.
      * 5.1.9 ~~Explain how~~ Take spatial autocorrelation influences into account when interpreting geospatial data and selecting sampling strategies ~~and statistics~~.
      * 5.1.10 Perform requirements analysis for remotely sensed data acquisition using spatial, spectral, and temporal resolution ~~concepts~~ factors.
      * 5.1.11 ~~Explain~~ Account for the ~~concept of “bit depth” and its~~ implications ~~for remotely-sensed image data~~ of file size due to bit depth on file storage, processing designs, or additional color.
      * 5.1.13 ~~Recognize the differences between ellipsoidal (or geodetic) heights, geoidal heights, and orthometric elevation.~~ Employ appropriate techniques for working with height determinations based on their type (e.g., orthometric, ellipsoidal, geoid).
      * 5.1.14 Use differential correction techniques, both post-processing ~~(such as National Geodetic Survey’s Online Positioning Service)~~ and real-time ~~(such as Real Time Kinematic)~~, to improve the accuracy of GNSS data.
      * 5.1.16 ~~Interpret~~ Assess the quality of GNSS data based on possible sources of error.
      * 5.1.18 ~~Understand the process to~~ Produce an orthoimage data product with geometric accuracy suitable for project requirements.
      * 5.1.19 Understand how ~~aerotriangulation~~ aero-triangulation contributes to data quality confidence and is applicable to completing related tasks.
      * 5.1.21 ~~Understand how to~~ Conduct primary research ~~and implications of~~, appropriately respecting issues such as data privacy and confidentiality.
      * 5.1.22 ~~Describe how~~ Collect and geocode information ~~can be harvested and geocoded~~ from social media sources.
      * 5.1.23 ~~Explain the process of acquiring and integrating~~ Acquire and integrate large and heterogeneous datasets (both spatial ~~or~~ and nonspatial).
      * 5.1.25 Explain how to and use a mobile device ~~calculates~~ to calculate location coordinates ~~(e.g., GNSS, triangulation, trilateration, etc.)~~.
      * 5.1.26 ~~Compare~~ Select and use differential GNSS ~~and~~ or autonomous GNSS appropriately with respect to the differences between the systems.
  + Technical content areas
    - *Renumbered technical content area title and technical content areas:*
      * Renumbered technical content area title ~~5.1.26~~ as 5.1.27
      * Renumbered technical content areas ~~5.1.26.1-5.1.26.12~~ as 5.1.27.1-5.1.26.12.
    - *Edited technical content area:*
      * 5.1.27.2 Land Partitioning Systems, including metes and bounds, U.S. Public Land Survey (USPLS~~<~~), and long lots.
* **5.2 Analysis and Modeling**
  + Competency description
    - *Edited competency description:*
      * ~~Knowledge~~ Understanding and ~~application of~~ applying the analytical functions (“exploratory” analyses as well as model-driven analyses) of geospatial software tools.
  + Critical Work Functions
    - *Added critical work functions:*
      * 5.2.3 Develop new analysis procedures to solve novel or unstructured geospatial tasks.
      * 5.2.14 Take potential pre-processing into account when using products characterized as Analysis Ready Data (ARD).
    - *Edited critical work functions:*
      * 5.2.1 ~~Describe an example of a useful application of a~~ Perform a buffer operation in GIS software.
      * 5.2.2 ~~Perform a site~~ Implement standard analytical procedures to perform common geospatial tasks, such as suitability overlay analysis ~~using intersection and overlay functions of GIS software~~.
      * ~~5.2.3~~ 5.2.4 Use GIS software to identify an optimal route that accounts for visibility, slope, and specified land ~~uses~~ use or land cover.
      * ~~5.2.8~~ 5.2.7 ~~Understand how spatial data aggregation into different areal extents affects interpretation~~ Recognize the impact of ~~results (~~the Modifiable Areal Unit Problem~~)~~ on the apparent spatial and statistical patterns found in geospatial data.
      * ~~5.2.9~~ 5.2.8 ~~Explain characteristics and appropriate uses of~~ Select, use, and interpret geospatial modeling techniques appropriately with respect to their characteristics ~~(e.g. artificial intelligence, machine learning, and deep learning)~~.
      * ~~5.2.10~~ 5.2.9 ~~Demonstrate familiarity with the existence of~~ Apply predictive models ~~and their applications~~ to study geographic patterns and processes.
      * ~~5.2.13~~ 5.2.12 Determine the appropriate image data and image analysis techniques needed to fulfill project requirements.
      * ~~5.2.14~~ 5.2.13 ~~Explain the processes involved in~~ Pre-process digital remotely sensed data using procedures such as geometric correction, radiometric correction, and mosaicking with an awareness ~~of digital remotely sensed~~ their impact on data ~~and the resulting errors~~ quality.
      * 5.2.15 ~~Explain how to~~ Quantify the thematic accuracy of a land ~~use/land~~ cover map derived from remotely-sensed imagery.
      * 5.2.17 ~~Explain the difference between~~ Select and use pixel-based ~~and~~ or object-based ~~image~~ classification of imagery data appropriately based on data and project requirements.
    - *Deleted critical work functions:*
      * ~~5.2.4 Perform dynamic segmentation on transportation network data encoded in a linear reference system~~
      * ~~5.2.5 Explain how leading online routing systems work, and account for common geocoding errors~~
      * ~~5.2.18 Perform object-oriented image classification~~
    - *Renumbered critical work functions:*
      * ~~5.2.6~~ 5.2.5 Use location-allocation software functions to locate service facilities that satisfy given constraints.
      * ~~5.2.7~~ 5.2.6 Develop conceptual, logical, and physical models of a geospatial database designed in response to user requirements.
      * ~~5.2.11~~ 5.2.10 Employ cartographic techniques to represent different kinds of uncertainty, including uncertain boundary locations, transitional boundaries, and ambiguity of attributes.
      * ~~5.2.12~~ 5.2.11 Understand how to represent boundaries in plats, records, and descriptions, as stipulated in legal statute and precedent.
  + Technical content areas
    - *Renumbered technical content area titles and technical content areas:*
      * Renumbered technical content area titles ~~5.2.19-5.2.26~~ as 5.2.18-5.2.25
      * Renumbered technical content areas ~~5.2.19.1-5.2.26.2~~ as 5.2.18.1-5.2.25.2
    - *Edited technical content areas:*
      * ~~5.2.26.1~~ 2.2.25.1 Allied industries in which professionals need to understand geographic principles~~, such as~~: ~~Agribusiness; Economic Development; Military/Intelligence; Homeland Security; Emergency Management & E911; Environmental and Natural Resources; Forestry; Coastal and Marine Resources Management; Real Estate and Land Management; Telecommunications; Energy, Exploration and Mining; Utilities (Public and Private) and Power Generation; City, State, County, Provincial and other Local Government; Transportation and Logistics (Fleet Management, Mobile Resource Management, Road and Highway Planning and Maintenance); Urban and Regional Planning; Mobile Location-Based Services and Communication (Navigation, Location-based alerts, Location-based gaming, Location-based search); Telematics~~ 
        + Agribusiness;
        + Economic Development;
        + Military/Intelligence;
        + Homeland Security;
        + Emergency Management & E911;
        + Environmental and Natural Resources;
        + Forestry;
        + Coastal and Marine Resources Management;
        + Real Estate and Land Management;
        + Telecommunications;
        + Energy, Exploration and Mining;
        + Utilities (Public and Private) and Power Generation;
        + City, State, County, Provincial and other Local Government;
        + Transportation and Logistics (Fleet Management, Mobile Resource Management, Road and Highway Planning and Maintenance);
        + Urban and Regional Planning;
        + Mobile Location-Based Services and Communication (Navigation, Location-based alerts, Location-based gaming, Location-based search); and
        + Telematics
      * ~~5.2.26.2~~ 5.2.26.2 Allied industries in which geographic information is a crucial part of many job functions~~, including~~: ~~Advertising, Marketing and Market Research; Architecture, Engineering and Construction; Banking and Finance; Insurance; Cultural Resource Management; Health Care; Education; Journalism and Publishing; Law Enforcement; Manufacturing; Politics and Elections; Public Safety and Health; Restaurants and Food Service; Entertainment; Retail; Tourism~~
        + Advertising, Marketing and Market Research;
        + Architecture, Engineering and Construction;
        + Banking and Finance;
        + Insurance;
        + Cultural Resource Management;
        + Health Care;
        + Education;
        + Journalism and Publishing;
        + Law Enforcement;
        + Manufacturing;
        + Politics and Elections;
        + Public Safety and Health;
        + Restaurants and Food Service;
        + Entertainment;
        + Retail; and
        + Tourism
* **5.3 Software and Application Development**
  + Competency description
    - *Edited competency description:*
      * Design and development of geospatial software and applications, including GIS software products, applications for processing, ~~analysis~~ analyzing, or adding value to remotely sensed data, and applications to automate routine tasks and ~~to~~ customize end-user interfaces.
  + Critical work functions
    - *Added critical work functions:*
      * 5.3.7 Evaluate and choose the most appropriate means of communication (e.g., story maps, dashboards, web maps) for the intended audience, problem, and message.
      * 5.3.8 Recognize potentially sensitive location-based data and follow appropriate procedures to protect that information from public misuse.
      * 5.3.16 Develop an awareness of international geospatial initiatives, movements, and innovations.
      * 5.3.20 Build web-based geospatial services.
      * 5.3.21 Map and analyze data in a 3D environment.
    - *Edited critical work functions:*
      * 5.3.3 ~~Design~~ Implement a geospatial system architecture that responds to user needs, including desktop, server, and mobile applications.
      * 5.3.5 Optimize ~~geospatial system~~ the performance of geospatial software applications.
      * 5.3.6 Identify appropriate software development tools for particular end uses (e.g., web maps, mobile apps, desktop software).
      * ~~5.3.10~~ 5.3.11 Use scripting languages to automate repetitive geospatial analysis tasks.
      * ~~5.3.11~~ 5.3.12 Customize geospatial software using proprietary and open-source software components.
      * 5.3.15 Stay informed about trends and best practices in information technology and software engineering~~, such as unit testing, version control, and continuous integration~~.
      * ~~5.3.16~~ 5.3.17 Evaluate open-source software components for re-use and potential return contributions.
      * ~~5.3.17~~ 5.3.18 ~~Realize opportunities to~~ Leverage positioning technology to create ~~mobile~~ end-user applications.
      * ~~5.3.18~~ 5.3.19 ~~Explain how~~ Develop geospatial services that leverage cloud-based GIS architectures, such as ~~software in large enterprises fits into SOA (Service Oriented Architectures) and~~ SaaS (Software as a Service).
    - *Deleted critical work functions:*
      * ~~5.3.9 Automate geospatial analysis such as transformation, raster analysis, and geometric operations.~~
      * ~~5.3.14 Work effectively in teams to plan and coordinate software and application development.~~
      * ~~5.3.19 Be able to leverage web architectural opportunities.~~
    - *Renumbered critical work functions:*
      * ~~5.3.7~~ 5.3.9 Ensure that software code complies with industry standards, such as those promulgated by the Open Geospatial Consortium (OGC).
      * ~~5.3.8~~ 5.3.10 Identify the factors that affect the interoperability of geospatial software applications.
      * ~~5.3.12~~ 5.3.13 Use scripting languages or other tools to create web mapping applications.
      * ~~5.3.13~~ 5.3.14 Employ query languages such as SQL to interrogate spatial data.
  + Technical content areas
    - *Renumbered technical content area titles and technical content areas:*
      * Renumbered technical content area titles ~~5.3.20-5.3.21~~ as 5.3.22-5.3.23
      * Renumbered technical content areas ~~5.3.20.1-5.3.21.5~~ as 5.3.22.1-5.3.23.5

The Geospatial Technology Competency Model was updated in January 2019. The update focused on geospatial technology competencies and is shown below.

**About the Model**

Tier 4 – Industry-Wide Technical Competencies (p. 4)

## Replaced “core” with “crosscutting.” (Thus, the examples cited represent both the core crosscutting competencies of the geospatial field and the diversity of professional practice within it.)

## Tier 1 – Personal Effectiveness Competencies

* 1.3 Professionalism
  + *1.3.4 Social responsibility*
    - Moved bullet *1.3.4.1 Refrain from substance abuse* to *1.3.1 Demonstrating self-control*
    - Added bullet *1.3.4.1 Contribute to the wellbeing of your community (1.3.4.1)*

## Tier 2 – Academic Competencies

* 2.4 Geography
  + *2.4.3 Geographic Perspectives*
    - Moved bullet *4.1.8.5 Be familiar with the historical origins of geospatial technology to 2.4.3.4.*
    - Use basic computer software, hardware, and communication devices to perform tasks.
  + *2.5.2 Subject-specific Scientific Knowledge*
    - Edited bullet: *2.5.2.1 Physical Sciences, ~~including~~ such as Agricultural Science.*
    - Edited bullet: *2.5.2. Social Sciences, ~~including~~ such as Anthropology.*
  + *2.5.3 Engineering Methods*
    - Added bullet: *2.5.3.3 Understand the engineering disciplines that are appropriate to a chosen geospatial application domain.*
  + *2.8 Basic Computer Skills*
    - Added bullet and sub-bullets:
      * *2.8.7 Computer programming and algorithms*
        + *2.8.7.1 Basic understanding or appreciation of programming language principles*
        + *2.8.7.2 Code or script as needed*
        + *2.8.7.3 Develop web applications*

## Tier 3 - Workplace Competencies

* 3.3 Planning and Organizing
  + *3.3.3 Time Management*
    - Added bullets
      * *3.3.3.7 Working remotely*
      * *3.3.3.8 Understand or appreciate the impact of working remotely*
      * *3.3.3.9 Capability to work remotely as required*
  + *3.4.2 Generating Alternatives*
    - Added bullet
      * *3.4.2.5 Articulate a value proposition for particular customers, users, and stakeholders*

## Tier 4 - Industry-Wide Technical Competencies

* 4.1 Crosscutting Geospatial Abilities and Knowledge (edited name from Core Geospatial Abilities and Knowledge)
  + *4.1.2 Data Quality*
    - Edited bullet: *4.1.2.3 Identify data quality and integration problems likely to be associated with geospatial and attribute data acquired with legacy systems, ~~and~~ processes, and crowd sourcing*
    - *Edited bullet: 4.1.2.4 Calculate and interpret statistical methods and measures of the accuracy of a digital data set, such as Root Mean Square Error (RMSE), linear regression and standard deviation*
  + *4.1.3 Positioning Systems*
    - *Edited bullet: 4.1.3.1 Describe the basic components and operations of the Global Navigation Satellite System (GNSS), such as the Global Positioning System (GPS) and similar systems*
    - *Edited bullet: 4.1.3.3 Collect and integrate GNSS~~/GPS~~ positions and associated attribute data with other geospatial data sets*
  + *4.1.4 Remote Sensing and Photogrammetry*
    - *Edited bullet: 4.1.4.1 ~~Use~~ Explain the value ~~concept~~ of the electromagnetic spectrum ~~to explain the difference between sensors (e.g., optical, microwave, multispectral, hyperspectral, etc.)~~*
    - *Edited bullet: 4.1.4.2 Differentiate the several types of resolution that characterize remotely-sensed ~~imagery~~ data, including spatial, spectral, radiometric, and temporal~~, and extent~~*
    - *Edited bullet: 4.1.4.3 Describe characteristics, difference and appropriate uses of active and passive sensors (e.g., optical, microwave, multispectral, hyperspectral, etc)*
    - *Deleted bullet: 4.1.4.6 Define “orthoimagery” in terms of terrain correction and georeferencing*
    - *Added bullet: 4.1.4.6 Explain photogrammetric principles*
    - *Added bullet: 4.1.4.7 Compare the capabilities and limitation of various sensor platforms such as satellites, terrestrial, aircraft and unmanned aerial vehicles (UAVs)*
  + *4.1.6 Geographic Information System*
    - *Edited bullet: 4.1.6.7 Use geospatial software tools to perform basic GIS analysis functions, including spatial measurement, data query and retrieval, vector overlay, raster map algebra and to use large datasets (e.g., big data)*
    - *Edited bullet: 4.1.6.8 Demonstrate a working knowledge of GIS hardware and software capabilities~~, including real-time GPS/GIS mapping systems~~*
  + *4.1.7 Programming, application development, and geospatial information technology*
    - *Edited bullet: 4.1.7.7 Compare the capabilities, limitations, and the ability to integrate of different types of geospatial software, such as CAD, BIM, GIS and image processing*
  + *4.1.8 Professionalism*
    - *Moved 4.1.8.5 Be familiar with the historical origins of geospatial technology to 2.4.3.4*
  + *Edited: Technical Content Areas: Heading correspond to select knowledge areas identified in the first edition of the GIS&T Body of Knowledge (UCGIS 2006 as modified during the 2018 GTCM review).*
  + *4.1.10 Geospatial Data*
    - *Edited bullet: 4.1.10.8 Data input, including field ~~data~~ collection, digitizing, scanning, crowd sourced, real time feeds, data conversion and integration*
    - *Edited bullet: 4.1.10.12 Metadata standards (e.g., ISO, FGDC, OGC) and spatial data infrastructure*
    - *Edited bullet: 4.1.10.13 Alternative positioning and tracking technologies, such as Wi-Fi, ~~TV~~, cellular, Bluetooth and RFID*
  + *4.1.11 Data Modeling*
    - *Added bullet: 4.1.11.5 Data accessibility and services*
  + *4.1.16 Organizational and Institutional Aspects*
    - *Edited bullet: 4.1.16.7 Standard organizations, such as FGDC, ISO and OGC*

## Tier 5 - Industry-Wide Technical Competencies

* 5.1 Positioning and Data Acquisition
  + *Edited bullet: 5.1.1 Use ~~specialized~~ geospatial software to transform ellipsoid, datum, and/or map projection to georegister one set of geospatial data to another*
  + *Edited bullet: 5.1.7 Design a ~~an integrated measurement~~ system for acquiring, processing and integrating geospatial data from diverse sources*
  + *Edited bullet: 5.1.13 ~~Illustrate~~ Recognize the differences between ellipsoidal (or geodetic) heights, geoidal heights, and orthometric elevation ~~in relation to GNSS~~*
  + *Deleted bullet: 5.1.14 Differentiate between Real time Precise Positioning Service (PPS) and Realtime Standard Positioning Service (SPS)*
  + *Edited bullet: 5.1.15 ~~Perform~~ Understand GNSS data post-processing (such as National Geodetic Survey’s Online Positioning Service) and real time (such as Real Time Kinematic) (now numbered 5.1.14)*
  + *Deleted bullet: 5.1.17 Explain GNSS data quality issues, such as multipath, PDOP, and signal to noise ration*
  + *Added bullet: 5.1.17 Interpret the quality of GNSS data based on possible source of error*
  + *Edited bullet: 5.1.19 Understand the process to produce an orthoimage data product with geometric accuracy suitable for project requirements*
  + *Edited bullet: 5.1.20 ~~Explain~~ Understand how aerotriangulation contributes to data quality confidence and is applicable to completing related tasks*
  + *Edited bullet: 5.1.21 Produce a metadata document that conforms to FGDC, ISO or other geospatial metadata standard*
  + *Edited bullet 5.1.23 Describe how textual information can be harvested and geocoded from social media ~~sites~~*
* 5.2 Analysis and Modeling
  + *Deleted bullet: 5.2.8 Explain the Modifiable Areal Unit Problem (e.g., ecological fallacy, choropleth mapping, etc.) with relation to data aggregation*
  + *Added bullet: 5.2.8 Understand how spatial data aggregation into different areal extents affects interpretation of results (Modifiable Areal Unit Problem)*
  + *Edited bullet: 5.2.9 Explain characteristics and appropriate uses of geospatial modeling techniques (e.g., ~~neural networks, cellular automata,~~ artificial intelligence, machine learning, ~~heuristics, agent-based models,~~ and ~~simulation models~~ deep learning)*
  + *Edited bullet: 5.2.12 ~~Establish, re-establish and/or monument property boundaries;~~ Understand how to represent ~~such~~ boundaries in plats, records, and descriptions, ~~all under personal and professional liability~~ as stipulated in legal statute and precedent*
  + *Edited bullet: 5.2.14 ~~Outline workflows that identify sequence of procedures~~ Explaing the processes involved in geometric correction, radiometric correction, and mosaicking of remotely sensed data*
  + *Edited bullet 5.2.16 ~~Evaluate~~ Determine the thematic accuracy of a data product ~~derived from aerial image interpretation, such as a soils map,~~ using ground verification methods*
  + *Edited bullet: 5.2.18 Perform object-oriented image classification ~~using specialized software tools~~*
* 5.3 Software and Application Development
  + *Deleted bullet 5.3.7: Create geospatial software programs such as C, C++, and Java*
  + *Added bullet 5.3.7: Use programming languages*
  + *Edited bullet 5.3.10: Automate geospatial analysis ~~methods~~ such as transformations, raster analysis, and geometric operations*
  + *Edited bullet 5.3.12: Customize geospatial software using proprietary and open source software components~~, such as ESRI’s ARcObjects, Intergraph’s GeoMedia software suite, and the GeoTools open source project~~*
  + *Edited bullet 5.3.13: Use scripting languages ~~such as JavaScript, PHP, and KML or other tools~~ to create web mapping applications*
  + *Edited bullet 5.3.14: Employ query languages such as SQL to interrogate spatial data~~bases~~*
  + *Edited bullet 5.3.20: Be able to leverage ~~new~~ web architectural opportunities ~~such as cloud computing~~*